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Cold Forming Process for Manufacturing Ball Pivots

Specification

The present invention pertains to a cold forming process for manufacturing ball pivots with a ball area, a cone area and a thread area for installation in ball and socket joints.

Machining as well as non-machining manufacturing processes are used, in principle, to manufacture ball pivots that are intended for installation in ball and socket joints. Larger amounts of waste material, which must be disposed of, take place during machining. In addition, there is a disadvantage that the waste material must first be purchased as a semifinished product. In addition, it is disadvantageous that cycle times that would substantially exceed a number of 10 pieces per minute are not possible on the machine tools that are commonly used at present. Moreover, it is necessary in case of machining that at least the thread area must be machined by a rolling operation in order to prepare the necessary threads in this area. The cycle times of such rolling operations are likewise in the above-mentioned range of about 10 pieces per minute.

As an alternative to machining, it is known in the state of the art that ball pivots can be manufactured according to the cold or hot process by pressing. The pressing operations can be carried out in the direction of the longitudinal axis of the ball pivot, in which case a residual flash is formed at one end of the ball pivot blank, or they are carried out horizontally in a two-part pressing die, in which case a burr is formed circularly around the entire pressed blank. The burrs formed are removed by a finishing machining operation corresponding to the state of the art. Thus, cost-intensive and time-consuming operations are generated until the ball pivot is

manufactured in case of non-machining forming of the ball pivot as well.

In addition, ball pivots that have a multipart design are known from the state of the art, but their manufacture shall not be discussed in greater detail here, because the process according to the present invention pertains to the manufacture of one-part ball pivots.

The object of the present invention is to disclose a process for manufacturing ball pivots with a ball area, a cone area and a thread area, in which the number of pieces per unit of time for manufacturing individual ball pivots can be substantially reduced, so that the necessary manufacturing costs can be significantly reduced.

This object is accomplished according to the present invention by the technical teaching disclosed in claim 1. It is essential for the present invention that a ball pivot blank with a formed cone area and with cylindrical areas for the thread and the ball is first manufactured from a bar-shaped semifinished bar stock by means of extrusion, the extrusion flash being arranged at the free end of the area intended for forming the ball, and that the ball area is subsequently formed in another operation by means of a triggered synchronized rolling process by rolling forming bodies.

Any machining can be done away with due to the novel combination of the process steps described. During the pressing operation and the subsequent rolling alike, the cycle times are approx. 100 pieces per minute during pressing and in the range of about 50 pieces per minute during rolling.

The rolling process may be a so-called flat jaw rolling process or a round-jaw rolling process.

Due to the combination of the manufacturing operations, it is thus possible to manufacture a

considerably greater number of ball pivots than has hitherto been known from the state of the art. This becomes possible, among other things, due to the fact that a plurality of functional areas, for example, the ball area, the cone area and the thread area, can be machined simultaneously by a tool during flat jaw rolling or round-jaw rolling. Moreover, the disposal of any waste material, which is absolutely necessary in case of manufacture by machining, is obviously eliminated.

Since the investment for a rolling machine is in the same cost range as for purchasing a lathe, the new inventive solution also leads to cost advantages in the area of the initial investment for manufacturing ball pivots due to the higher output of workpieces.

Moreover, it proved to advantageous in the process according to the present invention to form at first a neck area between the cone area and the cylindrical area intended for forming the ball during the flat-jaw or round-jaw rolling. Examples of strength measurements on ball pivots manufactured according to the novel process have revealed that the fatigue strength of the ball pivots can be increased by up to 50% by forming a neck area by rolling. Due to the increase in the fatigue strength by rolling a neck, it also becomes possible to use steels with microalloying elements, whose purchase price is substantially lower than that of the heat-treatable steels necessary for heat treatments. The cold forming of the C-Mn steels alloyed with microalloying elements is sufficient especially in the neck area to reach a sufficient strength. The increase in the strength values can be used to reduce the overall size of corresponding ball pivots at equal external loads.

Furthermore, it proved to be expedient as another special embodiment of the process according to the present invention that a blind hole-like recess, which is open on the front side, is pressed before the rolling operation into the free end of the ball pivot blank, which free end is intended for forming the ball area. The blind hole-like recess may be formed by the upper die used for

pressing. The recess facilitates the forming of the cylindrical partial area of the ball pivot intended for forming the ball area to its final spherical shape. In addition, the recess does, of course, represent saving of material. If the blind hole-like recess, the so-called pole hole, is still present at least partly after the manufacture of the ball area of the ball pivot, the recess may be used, for example, to receive sensors or used as a grease reservoir. Closing the pole hole, for example, by means of a plastic cover is, of course, also conceivable in this connection.

The operations during both flat-jaw rolling and round-jaw rolling will be explained in greater detail below on the basis of the attached drawings. In the drawings,

Figure 1 shows the side view of a ball pivot blank before the ball area is formed by means of the triggered synchronized rolling process,

Figure 2 shows a schematic top view of a flat-jaw rolling device with a ball pivot arranged therein during the rolling operation,

Figure 3A shows a sectional view through the flat-jaw rolling device at the beginning of the rolling operation corresponding to section line A-A in Figure 2,

Figure 3B shows a sectional view through the flat-jaw rolling device during the rolling operation corresponding to section line B-B in Figure 2,

Figure 3C shows a sectional view through a flat-jaw rolling device at the end of the forming process for the ball pivot corresponding to section line C-C in Figure 2,

Figure 4 shows a schematic sectional view through a round-jaw rolling device with a ball

pivot blank arranged therein,

Figure 5 shows a top view of the round-jaw rolling device according to Figure 4,

Figure 6 shows a perspective view of another variant of a round-jaw rolling device with a ball pivot blank arranged therein,

Figure 7 shows a schematic view through a round-jaw rolling device with a ball pivot blank arranged therein, and

Figure 8 shows a top view of the round-jaw rolling device according to Figure 7.

The ball pivot blank shown in Figure 1 is manufactured by means of an extrusion process and comprises essentially a plurality of partial areas of different three-dimensional shapes arranged one after another in the longitudinal direction of the ball pivot. After extrusion, the different areas are to be formed into their final shape by means of the combination of process features that are essential for the present invention, and a ball pivot shape corresponding to the view in Figure 3C is obtained after completion of the cold forming according to the present invention.

Thus, the ball pivot blank, designated by 1 as a whole, comprises, according to the view in Figure 1, a cylindrical area 2, which is arranged at a free end of the ball pivot blank 1 and on which a thread for fastening the ball pivot to a machine or body component is located after the completion of the ball pivot. The cylindrical area 2 is joined directly by a cone area 3. This cone area 3 has, in principle, already its finished dimensions after the extrusion operation, and smoothing of the conical surface can be brought about in a subsequent operation. The cone area 3 is joined, in turn, by another cylindrical area 4, which comprises the so-called neck section of the finished ball

pivot and in which an incision is made as a transition to the area adjoining it corresponding to the view in Figure 3C. Another cylindrical area 5, which may have a semicircular partial area 6 in the transition to the cylindrical area 4, is arranged at the second free end of the ball pivot blank 1 as the final area of the ball pivot blank 1. As an alternative to the semicircular shape of the partial area 6, a conical transition to the cylindrical area 4 is also conceivable here. The cylindrical area 4 mentioned last is to be reduced to a spherical shape within the framework of the process according to the present invention, so that the ball head 18 shown in Figure 3C is obtained at the upper free end of the ball pivot. To facilitate the forming process, an essentially likewise cylindrical recess 7 in the form of a blind hole may be prepared in the cylindrical area 5 at the upper free end. This may happen within the framework of the preceding extrusion operation and is carried out by means of the upper die of the extruder. The two halves of the pressing die are shaped such that the parting line of the two halves is located in the area of the parting line 8, so that the parting plane of the die and accumulations of burr that may possibly be associated therewith are located outside the cylindrical area 5 that is to be brought to a spherical shape.

In principle, three possible variants of rolling process are available for the final shaping of the ball pivot blank 1 by means of a triggered synchronized rolling process by rolling forming bodies. These three different processes will be explained below on the basis of the drawings.

At first, the so-called flat-jaw rolling process is presented as a variant of the rolling process. The corresponding rolling device used in this rolling process comprises two flat jaws 9 and 10, one of the flat jaws, the one designated by 9 in this view in Figure 2, being designed as a stationary flat jaw, whereas the flat jaw 10 located opposite performs a translatory motion in the direction of arrow P. The roll gap 11 with an inlet area 12 and with an outlet area 13 is located between the flat jaws 9 and 10. The ball pivot blank 1 is introduced into the roll gap 11 at the beginning of the flat-jaw rolling process in the area of the section line A-A, and the mobile rolling jaw 10 assumes

a position corresponding to the dash-dotted view. Due to the displacement of the mobile flat jaw 10 and the resulting rolling motion of the ball pivot blank 1, the latter is transported through the roll gap 11. Both the ball pivot and the neck area adjoining same are formed during the motion of the ball pivot blank within the roll gap 11. For forming, the flat jaws 9 and 10 have, corresponding to Figure 3A, a contour that corresponds essentially to that of the ball pivot blank 1 at the beginning of the rolling operation proper. The ball pivot blank 1 is shown for this purpose together with the flat jaw 9 in Figure 3A. The contour profile of the other flat jaw 10 shown in Figures 3A, 3B and 3C corresponds, in principle, to that of the flat jaw 9 shown in the figures. The profile of the flat jaws 9 and 10 changes continuously on the lateral surfaces 14 and 15 facing each other to the finished contour profile in the outlet area 13 corresponding to Figure 3C on the finished ball pivot. Due to the translatory motion of the mobile flat jaw 10, the starting profile of the flat jaw 9 shown in Figure 3A is located, of course, in the lower area in the area of point C on the flat jaw 10 in the view according to Figure 2, whereas the end profile of the flat jaw 9 shown in Figure 3C is located in the area of point A on the flat jaw 10. Thus, the flat jaws 9 and 10 are symmetrical in the area of the section line B-B in Figure 2. It appears from the change in the contours of the lateral surfaces 14 and 15 of the flat jaws 9 and 10 that the forming of the ball pivot as well as of the neck area takes place in phases one after another. After the ball pivot blank 1 has been introduced into the roll gap 11, the neck part 16 is formed at first, and a depression is prepared at the same time in the head area 17 of the cylindrical area 5, which is facilitated by the recess 7 explained on the basis of Figure 1 at the free end of the ball pivot blank 1. The formation of the neck part 16 by means of the rolling process leads to a substantial increase in strength in this area, because, contrary to machining, no material is removed, but the material of the ball pivot blank is rather formed in the area.

The final forming of the ball head 18 to its final shape is then performed during the further course of the rolling operation between the area of the section lines B-B and C-C, the mobile flat jaw 10

assuming position III indicated by dotted line in Figure 2 at the end of the rolling operation. At the same time, smoothing of the surface of the cone area 3 of the ball pivot blank 1 can be performed during the entire rolling operation due to suitable shaping of the contour of the respective lateral surfaces 14 and 15 of the flat jaws 9 and 10. Moreover, it is, of course, also possible to prepare the necessary thread in the cylindrical area 2 at the lower free end of the ball pivot blank 1. Thus, a corresponding shaping of the entire ball pivot may thus optionally take place due to the corresponding shape of the flat jaws during a translatory motion of the mobile flat jaw 10, without removal of material and disposal of material being necessary, unlike in case of machining. In addition, the rolling operation as a whole leads to an increase in the strength of the surface, so that subsequent hardening procedures can be eliminated.

The described course of the rolling operation for manufacturing the finished ball pivot may also be carried out, as an alternative to the flat jaw rolling process, by means of devices whose rolling jaws have a curved shape. A first shape of round-jaw rolling will be explained below at first on the basis of the views in Figures 4 and 5. The round-jaw rolling device comprises, corresponding to the views in Figures 4 and 5, two rolling cylinders 21 and 22, which are arranged next to one another on parallel axes of rotation 19 and 20. Analogously to flat-jaw rolling, a roll gap 11, into which the ball pivot blank 1 is introduced, is formed between the two rolling cylinders. Both rolling cylinders 21 and 22 have on their jacket surfaces the negative form of the contour of both the ball pivot blank 1 and the contour of the finished ball pivot in an another angular area, which may be arranged offset by about 270° on the circumference. The rolling operation is carried out by opposite rotary motions of the rolling cylinders 21 and 22, the ball pivot itself remaining stationary in the roll gap 11.

The views in Figures 4 and 5 show a position of the rolling cylinders immediately after the introduction of the ball pivot blank 1 into the roll gap 11. At the same time, it can be recognized

from the sectional view in Figure 4 that a profile, which corresponds essentially to that of Figure 3B of the flat jaw 9 shown there, is formed on the circumference of the rolling cylinders 21 and 22 offset by 180° in the area of the points P1 and P2. A contour corresponding to Figure 3C with the flat jaw 9 shown there is formed on the circumference of the rolling cylinders 21 and 22 in the area of points P3 and P4. The rolling operation to which the ball pivot blank is subjected until it obtains its final shape thus takes place during a rotation of the rolling cylinders 21 and 22 by 270°. Simultaneous smoothing of the cone area 3 of the ball pivot blank 1 as well as the preparation of the necessary thread in the cylindrical area 2 may, of course, likewise be performed during the so-called round-jaw rolling process.

Devices in which one rolling jaw is formed by a rolling cylinder 23 similar to that of the above-described first variant, whereas the second rolling jaw is formed by a hollow rolling cylinder 24 concentrically surrounding the rolling cylinder, are suitable as another variant of a so-called round-jaw rolling process. Analogously to the above-described alternative rolling processes, a roll gap 11, into which the ball pivot blank 1 to be formed is introduced, is obtained between the rolling cylinder 23 and the hollow rolling cylinder 24 surrounding this, corresponding to Figure 6. The variable shape of the contour of the ball pivot blank 1 to be rolled is embossed on the inner jacket surface of the hollow rolling cylinder 24 as well as on the outer jacket surface of the rolling cylinder 23. The rolling operation process is carried out by rotating the rolling cylinder 23 and the hollow rolling cylinder 24 in opposite directions relative to one another, the relative motion of the rolling cylinder 23 and the hollow rolling cylinder 24 being decisive for the shaping. Thus, it may possibly also be sufficient to rotate only one of the cylinders 23 or 24, while the other is stopped. Both the ball head and the neck part and, moreover, optionally the cone area as well as the thread area of the finished ball pivot can be formed in this process as well. Thus, this other variant of round-jaw rolling also offers the corresponding advantages in terms of high manufacturing output as well as an increase in strength compared to the processes known from the state of the art.

The forming of the ball pivot may also be carried out with a round-jaw rolling device, which is known per se, as it is shown as an example in Figures 7 and 8.

The ball pivot blank 1 is processed in this case by rolling the symmetrical rolling cylinders 25 and 26, which rotate about their axes of rotation. The ball pivot blank 1 is arranged between the rolling cylinders 25, 26 in the roll gap 11. The ball pivot blank 1 receives its spherical shape due to the correspondingly shaped circumferential geometry of the rolling cylinders 25, 26. A negative contour, which may also form the cylindrically shaped area 5 of the ball pivot blank 1, is molded in the respective jacket surfaces 27 and 28 of the rolling cylinders 25, 26. The rotating rolling cylinders 25, 26 are at first moved toward the ball pivot blank 1. This feed motion may be brought about, for example, by means of a hydraulic cylinder.

List of Reference Numbers

1	Ball pivot blank
2	Cylindrical area
3	Cone area
4	Cylindrical area
5	Cylindrical area
6	Semicircular partial area
7	Recess
8	Parting line
9	Flat jaw
10	Flat jaw
11	Roll gap
12	Inlet area
13	Outlet area
14	Lateral surface
15	Lateral surface
16	Neck part
17	Head area
18	Ball head
19	Axis of rotation
20	Axis of rotation
21	Rolling cylinder
22	Rolling cylinder
23	Rolling cylinder
24	Hollow rolling cylinder

25 Rolling cylinder

26 Rolling cylinder

27 Jacket surface